

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE
in its capacity as elected Office

Date of mailing (day/month/year) 21 March 2001 (21.03.01)	
International application No. PCT/FI00/00652	Applicant's or agent's file reference BP100052
International filing date (day/month/year) 18 July 2000 (18.07.00)	Priority date (day/month/year) 19 July 1999 (19.07.99)
Applicant KAITILA, Jyrki et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:
15 February 2001 (15.02.01)

☐ in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Charlotte ENGER Telephone No.: (41-22) 338.83.38
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PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

BERGGREN OY AB
P.O. Box 16
FIN-00100 Helsinki
FINLANDE

Date of mailing (day/month/year) 08 January 2002 (08.01.02)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference BP100052	
International application No. PCT/FI00/00652	International filing date (day/month/year) 18 July 2000 (18.07.00)

1. The following indications appeared on record concerning:

☒ the applicant ☐ the inventor ☐ the agent ☐ the common representative

Name and Address

NOKIA MOBILE PHONES LTD.
Keilalahdentie 4
FIN-02150 Espoo
Finland

State of Nationality

FI

State of Residence

FI

Telephone No.

Facsimile No.

Teleprinter No.

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☒ the name ☐ the address ☐ the nationality ☐ the residence

Name and Address

NOKIA CORPORATION
Keilalahdentie 4
FIN-02150 Espoo
Finland

State of Nationality

FI

State of Residence

FI

Telephone No.

Facsimile No.

Teleprinter No.

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned
<input type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland Facsimile No.: (41-22) 740.14.35	Authorized officer Marie-José DEVILLARD Telephone No.: (41-22) 338.83.38
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PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference BP100052/SKU/PKK	FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/FI00/00652	International filing date (day/month/year) 18.07.2000	Priority date (day/month/year) 19.07.1999
International Patent Classification (IPC) or national classification and IPC ₇ H 03 H 9/15		
Applicant Nokia Mobile Phones Ltd. et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 15.02.2001	Date of completion of this report 20.11.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88 Form PCT/IPEA/409 (cover sheet) (January 1998)	Authorized officer Stefan Hultquist/MN Telephone No. 08-782 25 00

Telex
17978
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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI00/00652

I. Basis of the report

1. With regard to the elements of the international application:*

- ☐ the international application as originally filed
- ☒ the description:
 pages 1-4, 7-11, as originally filed
 pages _____, filed with the demand
 pages 5, 6, filed with the letter of 05.11.2001
- ☒ the claims:
 pages 1-11, as originally filed
 pages _____, as amended (together with any statement) under article 19
 pages _____, filed with the demand
 pages 12, 13, filed with the letter of 05.11.2001
- ☒ the drawings:
 pages 1-4, as originally filed
 pages _____, filed with the demand
 pages _____, filed with the letter of _____
- ☐ the sequence listing part of the description:
 pages _____, as originally filed
 pages _____, filed with the demand
 pages _____, filed with the letter of _____

2. With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item. These elements were available or furnished to this Authority in the following language _____ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI00/00652

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability: citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	<u>1-11</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-11</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-11</u>	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

During the international search, the following most relevant document was found:

D1: DE 19922146 A1

D2: JP 9181560 A

D3: EP 0834989 A2

D1 discloses a piezoelectric resonator for a band blocking circuit or a discriminator. The resonator is an energy capture device adapted to vibrate at the third harmonic of the lateral expansion vibration. It contains a piezoelectric resonator component, a piezoelectric substrate and two stimulation electrodes. There is also a housing element and a sealing region. The electrodes are on either side of the substrate, in which a region of substrate between the electrodes acts as the vibration region. Its centre is offset with respect to a chamber formed in a housing to enclose the vibration region. The sealing region encloses the chamber to damp leakage vibrations.

The claimed thin film resonator structure contains a material layer, which covers a zone of the resonator area but has an opening uncovering at least a part of the active area (first area) of the resonator. The opening in the material layer thus defines in the active area a centre area, where vibrations are not dampened, and around the centre area a zone, where the vibrations are dampened more effectively. A thin film bulk acoustic wave resonator typically has a thickness of about 2-10 micrometer and an area of maximum 300 times 300 micrometer.

.../...

Supplemental Box

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V

Document D1 describes a single crystal piezoelectric resonator. The resonator assembly of D1 contains separate mechanical parts, as sealing the resonator between two substrate plans 3,4 provides a package. The active area (area covered by 2, 2a, 2b) of this single crystal resonator is uniform. A single crystal piezoelectric resonator typically has dimensions in the order of millimetres.

The edge areas of the substrate plates form a dampening zone, but there is a gap G between the active the active area and the dampening zone. The dampening substrate plates 3, 4 have openings (3a, 4a), but these openings define an area that is larger than the active area. The claimed thin film resonator structure is clearly different from D1 and thus novel.

Furthermore, D1 discusses in detail how to place the active area within the opening 3a, 4a (see figs. 3-6) - quite an opposite teaching compared to that of the present invention. It thus fails to disclose or even to hint to having an opening 3a, 4a having a size at most that of the active area.

Accordingly, a damping material layer forming a part of a thin film piezoelectric resonator, and having in the active area an opening, which size is at most the size of the active area, is a solution not anticipated by D1. The claimed thin film resonator structure and a filter having such a thin film resonator structure are therefore considered inventive in view of D1.

None of the cited documents D2 or D3, taken alone or in combination reveals the invention defined in claims 1-11. Documents D2 and D3 are considered to constitute the state of the art.

Accordingly D1-D3 are considered to describe the general state of the art. Therefore, the invention as claimed in claims 1-11 is novel (N), is considered to involve an inventive step (IS) and to have industrial applicability (IA).

5 These lateral resonance modes that are usually at different frequencies cause the surface of the resonator to oscillate. The piezoelectrically excited strongest resonance mode is called the main mode and the other piezoelectrically excited modes are called spurious resonance modes. The spurious resonance modes usually occur at somewhat lower and/or higher frequencies than the cut-off frequency of a resonator.

10 One of the desired properties of a filter is that at the frequencies which the filter passes, the response of the filter is as even as possible. The variations in the frequency response are called the ripple. The frequency response of a filter should thus be constant, for example in a bandpass filter, over the bandwidth of the filter. In the blocking frequencies the ripple is usually not a problem.

15 The problem with the spurious resonance modes of crystal resonators and, for example, BAW resonators is that the ripple in filters that are constructed using these resonators is at least partly caused by spurious resonance modes of the resonators. This is discussed, for example, in an article entitled "Thin film bulk acoustic wave filters for GPS", in 1992 Ultrasonic Symposium, pp. 471-476, by K. M. Lakin, G. R. Kline and K. T. McCarron. The spurious resonance modes deteriorate the properties of systems that comprise crystal resonators or BAW resonators. The ripple in a frequency response of a filter is one example of the effect of the spurious resonances.

20 An object of the invention is to provide a resonator structure. A further object is to provide a resonator structure having good electrical response. A further object of the invention is to provide a resonator structure that is easy to manufacture.

Objects of the invention are achieved by dampening the piezoelectrically excited wave near the edge of the piezoelectrically excitable area.

25 A resonator structure according to the invention is a thin film resonator structure comprising two conductor layers and a piezoelectric layer in between the conductor layers, said resonator structure having a first area over which said conductor layers and piezoelectric layer extend, which first area is a piezoelectrically excitable area of the resonator structure, and it is characterized in that the resonator structure further comprises at least one layer of material, said material dampening vibrations effectively, said at least one layer covering a zone and having an opening in the first area, said opening uncovering at most the first area and confining a center area in the first area, and the piezoelectrically excited vibrations being dampened more effectively in the zone than in the center area.

A filter according to the invention is a filter comprising at least one thin film resonator structure, which comprises two conductor layers and a piezoelectric layer in between the conductor layers, said resonator structure having a first area over which said conductor layers and piezoelectric layer extend, which first area is a piezoelectrically excitable area of the resonator structure, and it is characterized in that the resonator structure further comprises at least one layer of material, said material dampening vibrations effectively, said at least one layer covering a zone and having an opening in the first area, said opening uncovering at most the first area and confining a center area in the first area, and the piezoelectrically excited vibrations being dampened more effectively in the zone than in the center area.

A resonator structure according to the invention comprises two conductive layers and a piezoelectric layer between the conductive layers. The conductive layers form the electrodes of the resonator. The piezoelectric layer may be a piezoelectric crystal or it may be a thin-film layer of piezoelectric material.

An electrically excitable area of a resonator refers here to the area to which all the electrode layers and the piezoelectric layer(s) of the resonator extend. In a resonator structure according to the invention, there is a dampening zone that encircles a certain part of the electrically excitable area of the resonator. Term center area refers here to this part of the electrically excitable area, which is inside the dampening zone. The center area does not have to be, for example, in the center of the resonator area. The dampening zone may be partly or wholly inside the piezoelectrically excitable area or it may be just outside the piezoelectrically excitable area. In the last option to piezoelectrically excitable area forms the center area, in the other options a certain part of the piezoelectrically excitable area forms the center area.

Dampening at the edge of the piezoelectrically excitable area suppresses higher order lateral frequency modes, which are related to the spurious resonances. A relatively larger part of the wave of higher order lateral resonance modes than of the first order lateral resonance mode is confined to the edge of the piezoelectrically excitable area. Therefore modification of the properties of the edge of the piezoelectrically excitable area affects more the higher order lateral resonance modes.

A zone that attenuates vibration better than a center area it confines can be constructed, for example, by having a dampening layer, which has an opening within the piezoelectrically excitable area of the resonator. The opening defines the center area of the resonator. The dampening layer may be, for example, a frame-like layer;

Claims

1. A thin film resonator structure (600, 800, 810, 820) comprising two conductor layers (110, 120) and a piezoelectric layer (100) in between the conductor layers, said resonator structure having a first area over which said conductor layers and pie-
5 zoelectric layer extend, which first area is a piezoelectrically excitable area of the resonator structure, **characterized** in that the resonator structure further comprises at least one layer (801, 803, 804) of material, said material dampening vibrations ef-
fectively, said at least one layer covering a zone and having an opening (802) in the
10 first area, said opening uncovering at most the first area and confining a center area (604, 802) in the first area, and the piezoelectrically excited vibrations being damp-
ened more effectively in the zone than in the center area.
2. A resonator structure according to claim 1, **characterized** in that the material, which dampens vibrations effectively, is polymeric material.
3. A resonator structure according to claim 2, **characterized** in that the material is
15 polyimide.
4. A resonator structure according to claim 1, **characterized** in that the layer of ma-
terial, which dampens vibrations effectively, is adjacent to one of the conductor lay-
ers.
5. A resonator structure according to claim 4, **characterized** in that the layer of ma-
20 terial, which dampens vibrations effectively, is between one of the conductor layers
and the piezoelectric layer.
6. A resonator structure (810) according to claim 1, **characterized** in that the layer
of material, which dampens vibrations effectively, extends at least over the part of
the piezoelectric layer, which is not within the first area.
- 25 7. A resonator structure (800) according to claim 1, **characterized** in that the zone
(801) is within the first area.
8. A resonator structure (810) according to claim 1, **characterized** in that the zone
(803) is at least partly outside the first area.
9. A resonator structure (820) according to claim 1, **characterized** in that the zone
30 (804) substantially confines the first area.

10. A resonator structure according to claim 1, **characterized** in that it further comprises a second piezoelectric layer in between the conductive layers and a conductor layer in between the piezoelectric layers.

- 5 11. A filter comprising at least one thin film resonator structure which comprises two conductor layers (110, 120) and a piezoelectric layer (100) in between the conductor layers, said resonator structure having a first area over which said conductor layers and piezoelectric layer extend, which first area is a piezoelectrically excitable area of the resonator structure, **characterized** in that the resonator structure further
10 comprises at least one layer (801, 803, 804) of material, said material dampening vibrations effectively, said at least one layer covering a zone and having an opening (802) in the first area, said opening uncovering at most the first area and confining a center area (604, 802) in the first area, and the piezoelectrically excited vibrations being dampened more effectively in the zone than in the center area.

531 Rec'd PCT/PTK 17 JAN 2002

PATENTTIHAKEMUS NRO Appl. No. 991619	LUOKITUS <i>classification</i> H03H 9/25, 9/64
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TUTKITTU AINEISTO <i>Research material</i>
Patenttijulkaisu kokoelma (FI, SE, NO, DK, DE, CH, EP, WO, GB, US), tutkitut luokat <i>Published patent specifications searched classes</i> H03H 9/25, 9/64, H01P 1/12
Tiedonhaut ja muu aineisto <i>Data search and other material</i> EPOQUE2; WPI, PAJ, EPODOC

VIITEJULKAISUT <i>cited references</i>		
Kategoria*) <i>category</i>	Julkaisun tunnistetiedot <i>Identification data</i>	Koskee vaatimuksia <i>Relates to claims</i>
P,A	EP A 963 000 (H01P 1/12)	
P,A	EP A 962 999 (H01P 1/12)	
A	JP A 11191722 (H03H 9/64)	
A	JP A 10093384 (H03H 9/25)	
A	JP A 6232688 (H03H 9/72)	
A	JP A 11135852 (H01L 41/09)	
<p>*) X Patentoitavuuden kannalta merkittävä julkaisu yksinään tarkasteltuna Y Patentoitavuuden kannalta merkittävä julkaisu, kun otetaan huomioon tämä ja yksi tai useampi samaan kategoriaan kuuluva julkaisu A Yleistä tekniikan tasoa edustava julkaisu, ei kuitenkaan patentoitavuuden este A <i>Technological background, not a bar of novelty.</i></p>		
Päiväys <i>Date</i> 11.7.2000	Tutkija Juha Jukanen <i>Examiner</i>	

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

REC'D 29 NOV 2001

WIPO

PCT

Applicant's or agent's file reference BP100052/SKU/PKK		FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/FI00/00652	International filing date (day/month/year) 18.07.2000	Priority date (day/month/year) 19.07.1999	
International Patent Classification (IPC) or national classification and IPC ₇ H 03 H 9/15			
Applicant Nokia Mobile Phones Ltd. et al			

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 4 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 15.02.2001	Date of completion of this report 20.11.2001
Name and mailing address of the IPEA/SE Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88 Form PCT/IPEA/409 (cover sheet) (January 1998)	Authorized officer Stefan Hultquist/MN Telephone No. 08-782 25 00

Telex
17978
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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI00/00652

I. Basis of the report

1. With regard to the **elements** of the international application:*

- ☐ the international application as originally filed
- ☒ the description:
pages 1-4, 7-11, as originally filed
pages _____, filed with the demand
pages 5, 6, filed with the letter of 05.11.2001
- ☒ the claims:
pages 1-11, as originally filed
pages _____, as amended (together with any statement) under article 19
pages _____, filed with the demand
pages 12, 13, filed with the letter of 05.11.2001
- ☒ the drawings:
pages 1-4, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the sequence listing part of the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language _____ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheet/fig _____

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).**

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

** Any replacement sheet containing such amendments must be referred to under item I and annexed to this report.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.

PCT/FI00/00652

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**1. Statement**

Novelty (N)	Claims	<u>1-11</u>	YES
	Claims		NO
Inventive step (IS)	Claims	<u>1-11</u>	YES
	Claims		NO
Industrial applicability (IA)	Claims	<u>1-11</u>	YES
	Claims		NO

2. Citations and explanations (Rule 70.7)

During the international search, the following most relevant document was found:

D1: DE 19922146 A1

D2: JP 9181560 A

D3: EP 0834989 A2

D1 discloses a piezoelectric resonator for a band blocking circuit or a discriminator. The resonator is an energy capture device adapted to vibrate at the third harmonic of the lateral expansion vibration. It contains a piezoelectric resonator component, a piezoelectric substrate and two stimulation electrodes. There is also a housing element and a sealing region. The electrodes are on either side of the substrate, in which a region of substrate between the electrodes acts as the vibration region. Its centre is offset with respect to a chamber formed in a housing to enclose the vibration region. The sealing region encloses the chamber to damp leakage vibrations.

The claimed thin film resonator structure contains a material layer, which covers a zone of the resonator area but has an opening uncovering at least a part of the active area (first area) of the resonator. The opening in the material layer thus defines in the active area a centre area, where vibrations are not dampened, and around the centre area a zone, where the vibrations are dampened more effectively. A thin film bulk acoustic wave resonator typically has a thickness of about 2-10 micrometer and an area of maximum 300 times 300 micrometer.

.../...

Supplemental Box

(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: V

Document D1 describes a single crystal piezoelectric resonator. The resonator assembly of D1 contains separate mechanical parts, as sealing the resonator between two substrate plans 3,4 provides a package. The active area (area covered by 2, 2a, 2b) of this single crystal resonator is uniform. A single crystal piezoelectric resonator typically has dimensions in the order of millimetres.

The edge areas of the substrate plates form a dampening zone, but there is a gap G between the active the active area and the dampening zone. The dampening substrate plates 3, 4 have openings (3a, 4a), but these openings define an area that is larger than the active area. The claimed thin film resonator structure is clearly different from D1 and thus novel.

Furthermore, D1 discusses in detail how to place the active area within the opening 3a, 4a (see figs. 3-6) - quite an opposite teaching compared to that of the present invention. It thus fails to disclose or even to hint to having an opening 3a, 4a having a size at most that of the active area.

Accordingly, a damping material layer forming a part of a thin film piezoelectric resonator, and having in the active area an opening, which size is at most the size of the active area, is a solution not anticipated by D1. The claimed thin film resonator structure and a filter having such a thin film resonator structure are therefore considered inventive in view of D1.

None of the cited documents D2 or D3, taken alone or in combination reveals the invention defined in claims 1-11. Documents D2 and D3 are considered to constitute the state of the art.

Accordingly D1-D3 are considered to describe the general state of the art. Therefore, the invention as claimed in claims 1-11 is novel (N), is considered to involve an inventive step (IS) and to have industrial applicability (IA).

These lateral resonance modes that are usually at different frequencies cause the surface of the resonator to oscillate. The piezoelectrically excited strongest resonance mode is called the main mode and the other piezoelectrically excited modes are called spurious resonance modes. The spurious resonance modes usually occur at
5 somewhat lower and/or higher frequencies than the cut-off frequency of a resonator.

One of the desired properties of a filter is that at the frequencies which the filter passes, the response of the filter is as even as possible. The variations in the frequency response are called the ripple. The frequency response of a filter should thus be constant, for example in a bandpass filter, over the bandwidth of the filter. In the
10 blocking frequencies the ripple is usually not a problem.

The problem with the spurious resonance modes of crystal resonators and, for example, BAW resonators is that the ripple in filters that are constructed using these resonators is at least partly caused by spurious resonance modes of the resonators. This is discussed, for example, in an article entitled "Thin film bulk acoustic wave
15 filters for GPS", in 1992 Ultrasonic Symposium, pp. 471-476, by K. M. Lakin, G. R. Kline and K. T. McCarron. The spurious resonance modes deteriorate the properties of systems that comprise crystal resonators or BAW resonators. The ripple in a frequency response of a filter is one example of the effect of the spurious resonances.

An object of the invention is to provide a resonator structure. A further object is to provide a resonator structure having good electrical response. A further object of the
20 invention is to provide a resonator structure that is easy to manufacture.

Objects of the invention are achieved by dampening the piezoelectrically excited wave near the edge of the piezoelectrically excitable area.

A resonator structure according to the invention is a thin film resonator structure
25 comprising two conductor layers and a piezoelectric layer in between the conductor layers, said resonator structure having a first area over which said conductor layers and piezoelectric layer extend, which first area is a piezoelectrically excitable area of the resonator structure, and it is characterized in that the resonator structure further comprises at least one layer of material, said material dampening vibrations ef-
30 fectively, said at least one layer covering a zone and having an opening in the first area, said opening uncovering at most the first area and confining a center area in the first area, and the piezoelectrically excited vibrations being dampened more effectively in the zone than in the center area.

A filter according to the invention is a filter comprising at least one thin film resonator structure, which comprises two conductor layers and a piezoelectric layer in between the conductor layers, said resonator structure having a first area over which said conductor layers and piezoelectric layer extend, which first area is a piezoelectrically excitable area of the resonator structure, and it is characterized in that the resonator structure further comprises at least one layer of material, said material dampening vibrations effectively, said at least one layer covering a zone and having an opening in the first area, said opening uncovering at most the first area and confining a center area in the first area, and the piezoelectrically excited vibrations being dampened more effectively in the zone than in the center area.

A resonator structure according to the invention comprises two conductive layers and a piezoelectric layer between the conductive layers. The conductive layers form the electrodes of the resonator. The piezoelectric layer may be a piezoelectric crystal or it may be a thin-film layer of piezoelectric material.

An electrically excitable area of a resonator refers here to the area to which all the electrode layers and the piezoelectric layer(s) of the resonator extend. In a resonator structure according to the invention, there is a dampening zone that encircles a certain part of the electrically excitable area of the resonator. Term center area refers here to this part of the electrically excitable area, which is inside the dampening zone. The center area does not have to be, for example, in the center of the resonator area. The dampening zone may be partly or wholly inside the piezoelectrically excitable area or it may be just outside the piezoelectrically excitable area. In the last option to piezoelectrically excitable area forms the center area, in the other options a certain part of the piezoelectrically excitable area forms the center area.

Dampening at the edge of the piezoelectrically excitable area suppresses higher order lateral frequency modes, which are related to the spurious resonances. A relatively larger part of the wave of higher order lateral resonance modes than of the first order lateral resonance mode is confined to the edge of the piezoelectrically excitable area. Therefore modification of the properties of the edge of the piezoelectrically excitable area affects more the higher order lateral resonance modes.

A zone that attenuates vibration better than a center area it confines can be constructed, for example, by having a dampening layer, which has an opening within the piezoelectrically excitable area of the resonator. The opening defines the center area of the resonator. The dampening layer may be, for example, a frame-like layer;

Claims

1. A thin film resonator structure (600, 800, 810, 820) comprising two conductor layers (110, 120) and a piezoelectric layer (100) in between the conductor layers, said resonator structure having a first area over which said conductor layers and pie-
5 zoelectric layer extend, which first area is a piezoelectrically excitable area of the resonator structure, **characterized** in that the resonator structure further comprises at least one layer (801, 803, 804) of material, said material dampening vibrations ef-
fectively, said at least one layer covering a zone and having an opening (802) in the
10 first area, said opening uncovering at most the first area and confining a center area (604, 802) in the first area, and the piezoelectrically excited vibrations being damp-
ened more effectively in the zone than in the center area.
2. A resonator structure according to claim 1, **characterized** in that the material, which dampens vibrations effectively, is polymeric material.
3. A resonator structure according to claim 2, **characterized** in that the material is
15 polyimide.
4. A resonator structure according to claim 1, **characterized** in that the layer of material, which dampens vibrations effectively, is adjacent to one of the conductor lay-
ers.
5. A resonator structure according to claim 4, **characterized** in that the layer of ma-
20 terial, which dampens vibrations effectively, is between one of the conductor layers and the piezoelectric layer.
6. A resonator structure (810) according to claim 1, **characterized** in that the layer of material, which dampens vibrations effectively, extends at least over the part of the piezoelectric layer, which is not within the first area.
- 25 7. A resonator structure (800) according to claim 1, **characterized** in that the zone (801) is within the first area.
8. A resonator structure (810) according to claim 1, **characterized** in that the zone (803) is at least partly outside the first area.
9. A resonator structure (820) according to claim 1, **characterized** in that the zone
30 (804) substantially confines the first area.

10. A resonator structure according to claim 1, **characterized** in that it further comprises a second piezoelectric layer in between the conductive layers and a conductor layer in between the piezoelectric layers.
- 5 11. A filter comprising at least one thin film resonator structure which comprises two conductor layers (110, 120) and a piezoelectric layer (100) in between the conductor layers, said resonator structure having a first area over which said conductor layers and piezoelectric layer extend, which first area is a piezoelectrically excitable area of the resonator structure, **characterized** in that the resonator structure further comprises at least one layer (801, 803, 804) of material, said material dampening vibrations effectively, said at least one layer covering a zone and having an opening (802) in the first area, said opening uncovering at most the first area and confining a center area (604, 802) in the first area, and the piezoelectrically excited vibrations being dampened more effectively in the zone than in the center area.
- 10

PCT REQUEST

BP100052

Original (for SUBMISSION) - printed on 18.07.2000 10:45:40 AM

0	For receiving Office use only	
0-1	International Application No.	
0-2	International Filing Date	
0-3	Name of receiving Office and "PCT International Application"	
0-4	Form - PCT/RO/101 PCT Request Prepared using	PCT-EASY Version 2.90 (updated 10.05.2000)
0-5	Petition The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty	
0-6	Receiving Office (specified by the applicant)	National Board of Patents and Registration (Finland) (RO/FI)
0-7	Applicant's or agent's file reference	BP100052
I	Title of invention	RESONATOR STRUCTURE AND A FILTER HAVING SUCH A RESONATOR STRUCTURE
II	Applicant	
II-1	This person is:	applicant only
II-2	Applicant for	all designated States except US
II-4	Name	NOKIA MOBILE PHONES LTD.
II-5	Address:	Keilalahdentie 4 FIN-02150 Espoo Finland
II-6	State of nationality	FI
II-7	State of residence	FI
III-1	Applicant and/or inventor	
III-1-1	This person is:	applicant and inventor
III-1-2	Applicant for	US only
III-1-4	Name (LAST, First)	KAITILA, Jyrki
III-1-5	Address:	4. Linja 14 B 45 FIN-00530 Helsinki Finland
III-1-6	State of nationality	FI
III-1-7	State of residence	FI

PCT REQUEST

BP100052

Original (for SUBMISSION) - printed on 18.07.2000 10:45:40 AM

III-2	Applicant and/or inventor	
III-2-1	This person is:	applicant and inventor
III-2-2	Applicant for	US only
III-2-4	Name (LAST, First)	YLILAMMI, Markku
III-2-5	Address:	Peräsin 2A FIN-02320 Espoo Finland
III-2-6	State of nationality	FI
III-2-7	State of residence	FI
III-3	Applicant and/or inventor	
III-3-1	This person is:	applicant and inventor
III-3-2	Applicant for	US only
III-3-4	Name (LAST, First)	ELLÄ, Juha
III-3-5	Address:	Kääriäisentie 5 FIN-24800 Halikko Finland
III-3-6	State of nationality	FI
III-3-7	State of residence	FI
IV-1	Agent or common representative; or address for correspondence	
	The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:	agent
IV-1-1	Name	BERGGREN OY AB
IV-1-2	Address:	P.O. Box 16 FIN-00100 Helsinki Finland
IV-1-3	Telephone No.	+358-9-693 701
IV-1-4	Facsimile No.	+358-9-693 3944
IV-1-5	e-mail	email.box@berggren.fi
V	Designation of States	
V-1	Regional Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AP: GH GM KE LS MW MZ SD SL SZ TZ UG ZW and any other State which is a Contracting State of the Harare Protocol and of the PCT EA: AM AZ BY KG KZ MD RU TJ TM and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT EP: AT BE CH&LI CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE and any other State which is a Contracting State of the European Patent Convention and of the PCT OA: BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG and any other State which is a member State of OAPI and a Contracting State of the PCT

PCT REQUEST

BP100052

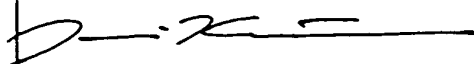
Original (for SUBMISSION) - printed on 18.07.2000 10:45:40 AM

V-2	National Patent (other kinds of protection or treatment, if any, are specified between parentheses after the designation(s) concerned)	AE AG AL AM AT AU AZ BA BB BG BR BY BZ CA CH&LI CN CR CU CZ DE DK DM DZ EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX MZ NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT TZ UA UG US UZ VN YU ZA ZW	
V-5	Precautionary Designation Statement In addition to the designations made under items V-1, V-2 and V-3, the applicant also makes under Rule 4.9(b) all designations which would be permitted under the PCT except any designation(s) of the State(s) indicated under item V-6 below. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit.		
V-6	Exclusion(s) from precautionary designations	NONE	
VI-1	Priority claim of earlier national application		
VI-1-1	Filing date	19 July 1999 (19.07.1999)	
VI-1-2	Number	991619	
VI-1-3	Country	FI	
VI-2	Priority document request The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) identified above as item(s):	VI-1	
VII-1	International Searching Authority Chosen	Swedish Patent Office (ISA/SE)	
VIII	Check list	number of sheets	electronic file(s) attached
VIII-1	Request	4	-
VIII-2	Description	11	-
VIII-3	Claims	2	-
VIII-4	Abstract	1	bp100052.txt
VIII-5	Drawings	4	-
VIII-7	TOTAL	22	
	Accompanying items	paper document(s) attached	electronic file(s) attached
VIII-8	Fee calculation sheet	✓	-
VIII-10	Copy of general power of attorney	✓	-
VIII-16	PCT-EASY diskette	-	diskette
VIII-18	Figure of the drawings which should accompany the abstract	7	
VIII-19	Language of filing of the international application	English	

PCT REQUEST

BP1CC052

Original (for SUBMISSION) - printed on 18.07.2000 10:45:40 AM

IX-1	Signature of applicant or agent	
IX-1-1	Name	BERGGREN OY AB
IX-1-2	Name of signatory	Juhani Kupiainen
IX-1-3	Capacity	Patent Attorney

FOR RECEIVING OFFICE USE ONLY

10-1	Date of actual receipt of the purported international application	
10-2	Drawings:	
10-2-1	Received	
10-2-2	Not received	
10-3	Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application	
10-4	Date of timely receipt of the required corrections under PCT Article 11(2)	
10-5	International Searching Authority	ISA/SE
10-6	Transmittal of search copy delayed until search fee is paid	

FOR INTERNATIONAL BUREAU USE ONLY

11-1	Date of receipt of the record copy by the International Bureau	
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PCT (ANNEX - FEE CALCULATION SHEET)

BP100052

Original (for **SUBMISSION**) - printed on 18.07.2000 10:45:40 AM

(This sheet is not part of and does not count as a sheet of the international application)

0	For receiving Office use only	
0-1	International Application No.	
0-2	Date stamp of the receiving Office	
0-4	Form - PCT/RO/101 (Annex)	
0-4-1	PCT Fee Calculation Sheet Prepared using	PCT-EASY Version 2.90 (updated 10.05.2000)
0-9	Applicant's or agent's file reference	BP100052
2	Applicant	NOKIA MOBILE PHONES LTD., et al.
12	Calculation of prescribed fees	fee amount/multiplier total amounts (FIM)
12-1	Transmittal fee T	⇒ 800
12-2	Search fee S	⇒ 5 618
12-3	International fee Basic fee (first 30 sheets) b1	2 431,8
12-4	Remaining sheets	0
12-5	Additional amount (X)	53,51
12-6	Total additional amount b2	0
12-7	b1 + b2 = B	2 431,8
12-8	Designation fees Number of designations contained in international application	87
12-9	Number of designation fees payable (maximum 8)	8
12-10	Amount of designation fee (X)	523,22
12-11	Total designation fees D	4 185,76
12-12	PCT-EASY fee reduction R	-749,16
12-13	Total International fee (B+D-R) I	⇒ 5 868,4
12-14	Fee for priority document Number of priority documents requested	1
12-15	Fee per document (X)	422
12-16	Total priority document fee P	⇒ 422
12-17	TOTAL FEES PAYABLE (T+S+I+P)	⇒ 12 708,4
12-19	Mode of payment	cheque

VALIDATION LOG AND REMARKS

13-2-3	Validation messages Names	Green? Applicant 1.:Telephone No. missing
		Green? Applicant 1.:Facsimile No. missing

PCT (ANNEX - FEE CALCULATION SHEET)

BP100052

Original (for SUBMISSION) - printed on 18.07.2000 10:45:40 AM

13-2-6	Validation messages Contents	Green? Reference number for attached copy of general power of attorney not indicated.
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IPEA/ SE

PCT

CHAPTER II

DEMAND

under Article 31 of the Patent Cooperation Treaty:

The undersigned requests that the international application specified below be the subject of international preliminary examination according to the Patent Cooperation Treaty and hereby elects all eligible States (except where otherwise indicated) ☐

For International Preliminary Examining Authority use only

Identification of IPEA	Date of receipt of DEMAND
------------------------	---------------------------

Box No. I IDENTIFICATION OF THE INTERNATIONAL APPLICATION	Applicant's or agent's file reference BP100052/SKU/PKK
International application No. PCT/FI00/00652	International filing date (day/month/year) 18 July 2000 (18.07.00)
	(Earliest) Priority date (day/month/year) 19 July 1999 (19.07.99)

Title of invention Resonator structure and a filter having such a resonator structure
--

Box No. II APPLICANT(S)	
Name and address: (Family name followed by given name; for a legal entity, full official designation) The address must include postal code and name of country: NOKIA MOBILE PHONES LTD. Keilalahdentie 4, FIN-02150 ESPOO, Finland	Telephone No. Facsimile No. Teleprinter No.

State (that is, country) of nationality: Finland	State (that is, country) of residence: Finland
---	---

Name and address: (Family name followed by given name; for a legal entity, full official designation) The address must include postal code and name of country: KAITILA, Jyrki 4. Linja 14 B 45, FIN-00530 HELSINKI, Finland

State (that is, country) of nationality: Finland	State (that is, country) of residence: Finland
---	---

Name and address: (Family name followed by given name; for a legal entity, full official designation) The address must include postal code and name of country: YLILAMMI, Markku Peräsin 2 A, FIN-02320 ESPOO, Finland

State (that is, country) of nationality: Finland	State (that is, country) of residence: Finland
---	---

☒ Further applicants are indicated on a continuation sheet.

Continuation of Box No II APPLICANT(S)*If none of the following sub-boxes is used, this sheet should not be included in the demand*

Name and address: (Family name followed by given name; for a legal entity, full official designation) The address must include postal code and name of country:

ELLÄ, Juha
Kääriäisentie 5, FIN-24800 HALIKKO, FinlandState (that is, country) of nationality:
FinlandState (that is, country) of residence:
Finland

Name and address: (Family name followed by given name; for a legal entity, full official designation) The address must include postal code and name of country:

State (that is, country) of nationality:

State (that is, country) of residence:

Name and address: (Family name followed by given name; for a legal entity, full official designation) The address must include postal code and name of country:

State (that is, country) of nationality:

State (that is, country) of residence:

Name and address: (Family name followed by given name; for a legal entity, full official designation) The address must include postal code and name of country:

State (that is, country) of nationality:

State (that is, country) of residence:

☐ Further applicants are indicated on another continuation sheet

Box No. III AGENT OR COMMON REPRESENTATIVE: OR ADDRESS FOR CORRESPONDENCEThe following person is ☒ agent ☐ common representativeand ☒ has been appointed earlier and represents the applicant(s) also for international preliminary examination ☐☐ is hereby appointed and any earlier appointment of (an) agent(s)/common representative is hereby revoked ☐☐ is hereby appointed, specifically for the procedure before the International Preliminary Examining Authority, in addition to the agent(s)/common representative appointed earlier ☐Name and address: *(Family name followed by given name; for a legal entity, full official designation)*
*The address must include postal code and name of country*BERGGREN OY AB
P.O. Box 16, FIN-00101 HELSINKI, Finland

Telephone No.

+358 9 693 701

Facsimile No.

+358 9 693 3944

Teleprinter No.

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent ☐**Box No. IV BASIS FOR INTERNATIONAL PRELIMINARY EXAMINATION****Statement concerning amendments:***1 ☐ The applicant wishes the international preliminary examination to start on the basis of:☒ the international application as originally filedthe description ☒ as originally filed☐ as amended under Article 34the claims ☒ as originally filed☐ as amended under Article 19 (together with any accompanying statement)☐ as amended under Article 34the drawings ☒ as originally filed☐ as amended under Article 342 ☐ The applicant wishes any amendment to the claims under Article 19 to be considered as reversed ☐3 ☐ The applicant wishes the start of the international preliminary examination to be postponed until the expiration of 20 months from the priority date unless the International Preliminary Examining Authority receives a copy of any amendments made under Article 19 or a notice from the applicant that he does not wish to make such amendments (Rule 69(d)) ☐ (This check-box may be marked only where the time limit under Article 19 has not yet expired)* Where no check-box is marked, international preliminary examination will start on the basis of the international application as originally filed or, where a copy of amendments to the claims under Article 19 and/or amendments of the international application under Article 34 are received by the International Preliminary Examining Authority before it has begun to draw up a written opinion or the international preliminary examination report, as so amended ☐**Language for the purposes of international preliminary examination:** English☒ which is the language in which the international application was filed ☐☒ which is the language of a translation furnished for the purposes of international search ☐☒ which is the language of publication of the international application ☐☐ which is the language of the translation (to be) furnished for the purposes of international preliminary examination ☐**Box No. V ELECTION OF STATES**

The applicant hereby elects all eligible States (that is, all States which have been designated and which are bound by Chapter II of the PCT)

excluding the following States which the applicant wishes not to elect:

Box No. VI CHECK LIST

The demand is accompanied by the following elements, in the language referred to in Box No. IV, for the purposes of international preliminary examination:

- | | | |
|--|---|--------|
| 1 <input type="checkbox"/> translation of international application: | : | sheets |
| 2 <input type="checkbox"/> amendments under Article 34 | : | sheets |
| 3 <input type="checkbox"/> copy (or, where required, translation) of amendments under Article 19 | : | sheets |
| 4 <input type="checkbox"/> copy (or, where required, translation) of statement under Article 19 | : | sheets |
| 5 <input type="checkbox"/> letter | : | sheets |
| 6 <input type="checkbox"/> other (specify): | : | sheets |

For International Preliminary Examining Authority use only

received not received

<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>

The demand is also accompanied by the item(s) marked below:

- | | |
|---|--|
| 1 <input checked="" type="checkbox"/> fee calculation sheet | 4 <input type="checkbox"/> statement explaining lack of signature |
| 2 <input type="checkbox"/> separate signed power of attorney | 5 <input type="checkbox"/> nucleotide and or amino acid sequence listing in computer readable form |
| 3 <input type="checkbox"/> copy of general power of attorney; reference number, if any: | 6 <input type="checkbox"/> other (specify): |

Box No. VII SIGNATURE OF APPLICANT, AGENT OR COMMON REPRESENTATIVE

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the demand):

BERGGREN OY AB

Sirpa Kuisma

Sirpa Kuisma
Patent Attorney

Helsinki, Finland, 15 February 2001

For International Preliminary Examining Authority use only

1 ☐ Date of actual receipt of DEMAND:

2 ☐ Adjusted date of receipt of demand due to CORRECTIONS under Rule 60 I(b):

3 ☐ The date of receipt of the demand is AFTER the expiration of 19 months from the priority date and item 4 or 5, below, does not apply ☐

☐ The applicant has been informed accordingly ☐

4 ☐ The date of receipt of the demand is WITHIN the period of 19 months from the priority date as extended by virtue of Rule 80.5 ☐

5 ☐ Although the date of receipt of the demand is after the expiration of 19 months from the priority date, the delay in arrival is EXCUSED pursuant to Rule 82 ☐

For International Bureau use only

Demand received from IPEA on:

PCT

FEE CALCULATION SHEET

Annex to the Demand for international preliminary examination

International application No. PCT/FI00/00652	For International Preliminary Examining Authority use only	
Applicant's or agent's file reference BP100052/SKU/PKK	Date stamp of the IPEA	
Applicant <div style="text-align: center; font-weight: bold;">NOKIA MOBILE PHONES LTD.</div>		
Calculation of prescribed fees		
1 <input type="checkbox"/> Preliminary examination fee	SEK 4200	<input type="checkbox"/> P
2 <input type="checkbox"/> Handling fee <i>(Applicants from certain States are entitled to a reduction of 75% of the handling fee. Where the applicant is (or all applicants are) so entitled, the amount to be entered at H is 25% of the handling fee.)</i>	SEK 1270	<input type="checkbox"/> H
3 <input type="checkbox"/> Total of prescribed fees Add the amounts entered at P and H and enter total in the TOTAL box	SEK 5470	
	TOTAL	
Mode of Payment		
<input type="checkbox"/> authorization to charge deposit account with the IPEA (see below)	<input type="checkbox"/> cash	
<input type="checkbox"/> cheque	<input type="checkbox"/> revenue stamps	
<input type="checkbox"/> postal money order	<input type="checkbox"/> coupons	
<input checked="" type="checkbox"/> bank draft via SWIFT through account 5439-10-013-49	<input type="checkbox"/> other (specify):	
Deposit Account Authorization <i>(this mode of payment may not be available at all IPEAs)</i>		
The IPEA/ <u>SE</u> <input type="checkbox"/> is hereby authorized to charge the total fees indicated above to my deposit account		
<input type="checkbox"/> <i>(this check-box may be marked only if the conditions for deposit accounts of the IPEA so permit)</i> is hereby authorized to charge any deficiency or credit any overpayment in the total fees indicated above to my deposit account		
Deposit Account Number	Date (day/month/year)	Signature

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

-7 -09- 2001

To:

Berggren Oy Ab
P.O. Box 16
FIN-00101 HELSINKI
Finland

PCT

WRITTEN OPINION

(PCT Rule 66)

Date of mailing
(day/month/year)

05 -09- 2001

Applicant's or agent's file reference

BP100052

REPLY DUE

within 60 days *fr. 4/11-01*
from the above date of mailing

International application No.

PCT/FI00/00652

International filing date (day/month/year)

18.07.2000

Priority date (day/month/year)

19.07.1999

International Patent Classification (IPC) or both national classification and IPC

H 03 H 9/15

Applicant

Nokia Mobile Phones Ltd. et al

1. This written opinion is the first (first, etc.) drawn by this International Preliminary Examining Authority.

2. This opinion contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability: citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☐ Certain defects in the international application
- VIII ☐ Certain observations on the international application

3. The applicant is hereby **invited to reply** to this opinion.

When? See the time limit indicated above. The applicant may, before the expiration of that time limit, request this Authority to grant an extension, see Rule 66.2(d).

How? By submitting a written reply, accompanied, where appropriate, by amendments, according to Rule 66.3. For the form and the language of the amendments, see Rules 66.8 and 66.9.

Also For an additional opportunity to submit amendments, see Rule 66.4.
For the examiner's obligation to consider amendments and/or arguments, see Rule 66.4bis.
For an informal communication with the examiner, see Rule 66.6.

If no reply is filed, the international preliminary examination report will be established on the basis of this opinion.

4. The final date by which the international preliminary examination report must be established according to Rule 69.2 is: 19.11.2001

Name and mailing address of the IPEA/SE

Patent- och registreringsverket
Box 5055
S-102 42 STOCKHOLM

Facsimile No. 08-667 72 88

Telex
17978

PATOREG-S

Authorized officer

Stefan Hultquist/mj
Telephone No. 08-782 25 00

Form PCT/IPEA/408 (cover sheet) (January 1998)

I. Basis of the opinion

1. With regard to the **elements** of the international application:*

- ☒ the international application as originally filed
- ☐ the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the claims:
pages _____, as originally filed
pages _____, as amended (together with any statement) under article 19
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the drawings:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____
- ☐ the sequence listing part of the description:
pages _____, as originally filed
pages _____, filed with the demand
pages _____, filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language _____ which is:

- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the written opinion was drawn on the basis of the sequence listing:

- ☐ contained in the international application in printed form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages _____
- ☐ the claims, Nos. _____
- ☐ the drawings, sheet/fig _____

5. ☐ This opinion has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2 (c)).

* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this opinion as "originally filed".

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability: citations and explanations supporting such statement**1. Statement**

Novelty (N)	Claims	<u>6, 8, 10-12</u>	YES
	Claims	<u>1-5, 7, 9</u>	NO
Inventive step (IS)	Claims	<u>6, 8, 10-12</u>	YES
	Claims	<u>1-5, 7, 9</u>	NO
Industrial applicability (IA)	Claims	<u>1-12</u>	YES
	Claims		NO

2. Citations and explanations

During the international search the following document was found:

D1: DE19922146 A1

According to D1, column 6, line 26-31, column 7, line 1-5, abstract and figures 1 and 2, a resonator structure comprising two conductor layers and a piezoelectric layer in between is shown. The conductor layers and the piezoelectric layer extends over a first area of the resonator structure, which first area is a piezoelectrically excitable area of the resonator structure. The structure is, as claimed in claim 1 of the invention, characterized in that the resonator structure is arranged to have a zone, which confines a center area within the first area of the resonator. The structure is further characterized in that a layer structure in the zone is arranged to be such that piezoelectrically excited vibrations is dampened more effectively in the zone than in the center area. The invention according to claims 1 is thus not novel.

As claimed in claims 2-5 in the present case, the resonator structure according to D1 comprises at least a layer of polymeric material (polyimide) adjacent to one of the conductor layers, which dampens vibrations effectively. Furthermore, regarding claim 7 and 9 of the claimed invention the resonator structure shown in D1 extends at least over the part of the piezoelectric layer, which is not within the first area. The aforementioned zone is in the present case, as in D1, at least partly outside the first area. The invention according to claims 2-5, 7 and 9 is thus not novel.

05 November 2001

Patent- och registreringsverket
Valhallavägen 136
P.O. Box 5055
S-102 42 STOCKHOLM
Sweden

Via facsimile: (2+4 pages)
999-46-8-667 72 88

URGENT

Authorized officer: Stefan Hultquist
Our ref: BP100052/SKU/MM

INTERNATIONAL PATENT APPLICATION NO. PCT/FI00/00652
APPLICANT: NOKIA MOBILE PHONES LTD.

In response to the Written Opinion mailed on 5 September 2001, we submit amended claims and respectfully present the following:

The enclosed claim 1 contains features of the original claims 1 and 2. The wording of the preamble is amended to define more clearly that the first area is that area over which the conducting layers and the piezoelectric layer extend. In addition, it specifies that the resonator is a thin film resonator (support on page 7, rows 17-21). It is also specified that the opening in the dampening material layer uncovers at most the active area (support in Figs. 8a, 8b and 8c).

The enclosed claim 11 (corresponding to the original claim 12) is amended to be in conformity with the enclosed claim 1. The enclosed claims 2-10 are renumbered original claims 3-11. The original claim 12 is cancelled.

The claimed thin film resonator structure contains a material layer, which covers a zone of the resonator area but has an opening uncovering at least part of the active area (first area) of the resonator. The opening in the material layer thus defines in the active area a center area, where vibrations are not dampened, and around the center area a zone, where the vibrations are dampened more effectively. A thin film bulk acoustic wave resonator typically has a thickness of about 2-10 μm and an area of maximum 300 μm x 300 μm .

Document D1 describes a single crystal piezoelectric resonator. The resonator assembly of D1 contains separate mechanical parts, as a package is provided by sealing the resonator between two substrate plates 3,4. The active area (area covered by 2, 2a and 2b) of this single crystal resonator is uniform. A single crystal piezoelectric resonator typically has dimensions in the order of millimeters.

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The edge areas of the substrate plates form a dampening zone, but there is a gap G between the active area and the dampening zone. The dampening substrate plates 3, 4 have openings (3a, 4a), but these openings define an area that is larger than the active area. The claimed thin film resonator structure is clearly different from D1 and thus novel.

Furthermore, D1 discusses in detail how to place the active area within the opening 3a, 4a (see Figs. 3-6) – quite an opposite teaching compared to that of the present invention. It thus fails to disclose or even to hint to having an opening 3a, 4a having a size at most that of the active area.

Based on the above we argue that a dampening material layer forming a part of a thin film piezoelectric resonator and having in the active area an opening, whose size is at most the size of the active area, is a solution not anticipated by D1. The claimed thin film resonator structure and a filter having such a thin film resonator structure are therefore considered inventive in view of D1.

A reconsideration of the statement regarding novelty and inventiveness of the claimed invention is respectfully requested.

The general description of the invention is brought into conformity with the enclosed claims; replacement pages 5 and 6 are enclosed.

BERGGREN OY AB



Sirpa Kuisma
Patent Attorney

Enclosures: replacement pages 5, 6, 12 and 13

These lateral resonance modes that are usually at different frequencies cause the surface of the resonator to oscillate. The piezoelectrically excited strongest resonance mode is called the main mode and the other piezoelectrically excited modes are called spurious resonance modes. The spurious resonance modes usually occur at
5 somewhat lower and/or higher frequencies than the cut-off frequency of a resonator.

One of the desired properties of a filter is that at the frequencies which the filter passes, the response of the filter is as even as possible. The variations in the frequency response are called the ripple. The frequency response of a filter should thus be constant, for example in a bandpass filter, over the bandwidth of the filter. In the
10 blocking frequencies the ripple is usually not a problem.

The problem with the spurious resonance modes of crystal resonators and, for example, BAW resonators is that the ripple in filters that are constructed using these resonators is at least partly caused by spurious resonance modes of the resonators. This is discussed, for example, in an article entitled "Thin film bulk acoustic wave
15 filters for GPS", in 1992 Ultrasonic Symposium, pp. 471-476, by K. M. Lakin, G. R. Kline and K. T. McCarron. The spurious resonance modes deteriorate the properties of systems that comprise crystal resonators or BAW resonators. The ripple in a frequency response of a filter is one example of the effect of the spurious resonances.

An object of the invention is to provide a resonator structure. A further object is to
20 provide a resonator structure having good electrical response. A further object of the invention is to provide a resonator structure that is easy to manufacture.

Objects of the invention are achieved by dampening the piezoelectrically excited wave near the edge of the piezoelectrically excitable area.

A resonator structure according to the invention is a thin film resonator structure
25 comprising two conductor layers and a piezoelectric layer in between the conductor layers, said resonator structure having a first area over which said conductor layers and piezoelectric layer extend, which first area is a piezoelectrically excitable area of the resonator structure, and it is characterized in that the resonator structure further comprises at least one layer of material, said material dampening vibrations effectively, said at least one layer covering a zone and having an opening in the first
30 area, said opening uncovering at most the first area and confining a center area in the first area, and the piezoelectrically excited vibrations being dampened more effectively in the zone than in the center area.

A filter according to the invention is a filter comprising at least one thin film resonator structure, which comprises two conductor layers and a piezoelectric layer in between the conductor layers, said resonator structure having a first area over which said conductor layers and piezoelectric layer extend, which first area is a piezoelectrically excitable area of the resonator structure, and it is characterized in that the resonator structure further comprises at least one layer of material, said material dampening vibrations effectively, said at least one layer covering a zone and having an opening in the first area, said opening uncovering at most the first area and confining a center area in the first area, and the piezoelectrically excited vibrations being dampened more effectively in the zone than in the center area.

A resonator structure according to the invention comprises two conductive layers and a piezoelectric layer between the conductive layers. The conductive layers form the electrodes of the resonator. The piezoelectric layer may be a piezoelectric crystal or it may be a thin-film layer of piezoelectric material.

An electrically excitable area of a resonator refers here to the area to which all the electrode layers and the piezoelectric layer(s) of the resonator extend. In a resonator structure according to the invention, there is a dampening zone that encircles a certain part of the electrically excitable area of the resonator. Term center area refers here to this part of the electrically excitable area, which is inside the dampening zone. The center area does not have to be, for example, in the center of the resonator area. The dampening zone may be partly or wholly inside the piezoelectrically excitable area or it may be just outside the piezoelectrically excitable area. In the last option to piezoelectrically excitable area forms the center area, in the other options a certain part of the piezoelectrically excitable area forms the center area.

Dampening at the edge of the piezoelectrically excitable area suppresses higher order lateral frequency modes, which are related to the spurious resonances. A relatively larger part of the wave of higher order lateral resonance modes than of the first order lateral resonance mode is confined to the edge of the piezoelectrically excitable area. Therefore modification of the properties of the edge of the piezoelectrically excitable area affects more the higher order lateral resonance modes.

A zone that attenuates vibration better than a center area it confines can be constructed, for example, by having a dampening layer, which has an opening within the piezoelectrically excitable area of the resonator. The opening defines the center area of the resonator. The dampening layer may be, for example, a frame-like layer;

Claims

1. A thin film resonator structure (600, 800, 810, 820) comprising two conductor layers (110, 120) and a piezoelectric layer (100) in between the conductor layers, said resonator structure having a first area over which said conductor layers and pie-
5 zoelectric layer extend, which first area is a piezoelectrically excitable area of the resonator structure, **characterized** in that the resonator structure further comprises at least one layer (801, 803, 804) of material, said material dampening vibrations effectively, said at least one layer covering a zone and having an opening (802) in the first area, said opening uncovering at most the first area and confining a center area
10 (604, 802) in the first area, and the piezoelectrically excited vibrations being dampened more effectively in the zone than in the center area.
2. A resonator structure according to claim 1, **characterized** in that the material, which dampens vibrations effectively, is polymeric material.
3. A resonator structure according to claim 2, **characterized** in that the material is
15 polyimide.
4. A resonator structure according to claim 1, **characterized** in that the layer of material, which dampens vibrations effectively, is adjacent to one of the conductor layers.
5. A resonator structure according to claim 4, **characterized** in that the layer of ma-
20 terial, which dampens vibrations effectively, is between one of the conductor layers and the piezoelectric layer.
6. A resonator structure (810) according to claim 1, **characterized** in that the layer of material, which dampens vibrations effectively, extends at least over the part of the piezoelectric layer, which is not within the first area.
7. A resonator structure (800) according to claim 1, **characterized** in that the zone
25 (801) is within the first area.
8. A resonator structure (810) according to claim 1, **characterized** in that the zone (803) is at least partly outside the first area.
9. A resonator structure (820) according to claim 1, **characterized** in that the zone
30 (804) substantially confines the first area.

10. A resonator structure according to claim 1, **characterized** in that it further comprises a second piezoelectric layer in between the conductive layers and a conductor layer in between the piezoelectric layers.
- 5 11. A filter comprising at least one thin film resonator structure which comprises two conductor layers (110, 120) and a piezoelectric layer (100) in between the conductor layers, said resonator structure having a first area over which said conductor layers and piezoelectric layer extend, which first area is a piezoelectrically excitable area of the resonator structure, **characterized** in that the resonator structure further comprises at least one layer (801, 803, 804) of material, said material dampening vibrations effectively, said at least one layer covering a zone and having an opening
10 (802) in the first area, said opening uncovering at most the first area and confining a center area (604, 802) in the first area, and the piezoelectrically excited vibrations being dampened more effectively in the zone than in the center area.

9 November 2001

Receiving Office
National Board of Patents and
Registration of Finland
Arkadiankatu 6 A
00100 Helsinki

INTERNATIONAL APPLICATIONS MERGER

The applicant of the PCT-applications listed below has changed. Nokia has merged its Finnish subsidiaries. As a result, **Nokia Mobile Phones Ltd.** and **Nokia Networks Oy** are now part of **Nokia Corporation**. The previous applicants should thereby be deleted and replaced by the following:

Nokia Corporation
Keilalahdentie 4
FIN-02150 Espoo
FINLAND

The applications concerned are:

Nokia Mobile Phones Ltd.:

Application:	Our ref:	Next deadline:
PCT/FI99/00722	OP0328	1 December 2001 (30 months)
PCT/FI00/00519	49807	10 December 2001 (30 months)
PCT/FI00/00529	50113	14 December 2001 (30 months)
PCT/FI00/00538	50115	16 December 2001 (30 months)
PCT/FI00/00620	50242	9 January 2002 (30 months)
PCT/FI00/00591	50236	19 January 2002 (30 months)
PCT/FI00/00652	BP100052	19 January 2002 (30 months)
PCT/FI01/00745	BP102211	25 March 2002 (Demand)
PCT/FI00/00863	BP100067	8 April 2002 (30 months)
PCT/FI00/00917	BP100182	25 April 2002 (30 months)
PCT/FI00/00920	BP100180	26 April 2002 (30 months)
PCT/FI00/00919	BP100181	26 April 2002 (30 months)
PCT/FI00/00955	BP100396	2 May 2002 (30 months)
PCT/FI00/01037	BP100397	30 May 2002 (30 months)
PCT/FI00/01087	BP100573	15 June 2002 (30 months)
PCT/FI00/01088	BP100572	15 June 2002 (30 months)
PCT/FI00/01152	BP100574	28 June 2002 (30 months)
PCT/FI00/01163	BP100884	30 June 2002 (30 months)

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PCT/FI01/00016	BP100778	10 July 2002 (30 months)
PCT/FI01/00023	BP100715	13 July 2002 (30 months)
PCT/FI01/00044	BP100519	21 July 2002 (30 months)
PCT/FI01/00093	BP100825	1 August 2002 (30 months)
PCT/FI01/00152	BP100546	16 August 2002 (30 months)
PCT/FI01/00183	BP100945	23 August 2002 (30 months)
PCT/FI01/00139	BP100948	24 August 2002 (30 months)
PCT/FI01/00190	BP101049	25 August 2002 (30 months)
PCT/FI01/00222	BP101116	7 September 2002 (30 months)
PCT/FI01/00325	BP101468	4 October 2002 (30 months)
PCT/FI01/00353	BP101149	10 October 2002 (30 months)
PCT/FI01/00369	BP101515	13 October 2002 (30 months)
PCT/FI01/00436	BP101421	8 November 2002 (30 months)
PCT/FI01/00438	BP101639	8 November 2002 (30 months)

Nokia Networks Oy:

Application:

Our ref:

Next deadline:

PCT/FI00/00555	50063	21 December 2001 (30 months)
PCT/FI00/00561	50192	24 December 2001 (30 months)
PCT/FI00/00615	50245	5 January 2002 (30 months)
PCT/FI00/00621	50193	9 January 2002 (30 months)
PCT/FI00/00622	50064	9 January 2002 (30 months)
PCT/FI00/00647	50194	14 January 2002 (30 months)
PCT/FI00/00654	50215	19 January 2002 (30 months)
PCT/FI00/00657	BP100021	23 January 2002 (30 months)
PCT/FI01/00599	BP101833	26 January 2002 (Demand)
PCT/FI00/00776	BP100158	16 March 2002 (30 months)
PCT/FI00/00786	BP100427	17 March 2002 (30 months)
PCT/FI00/00796	BP100152	20 March 2002 (30 months)
PCT/FI01/00734	BP101514	22 March 2002 (Demand)
PCT/FI01/00776	BP101753	7 April 2002 (Demand)
PCT/FI00/00869	BP100178	8 April 2002 (30 months)
PCT/FI00/00909	BP100167	20 April 2002 (30 months)
PCT/FI00/01021	BP100719	26 May 2002 (30 months)
PCT/FI00/01024	BP100582	26 May 2002 (30 months)
PCT/FI00/01117	BP100581	20 June 2002 (30 months)
PCT/FI01/00014	BP100868	7 July 2002 (30 months)
PCT/FI01/00018	BP100734	11 July 2002 (30 months)
PCT/FI01/00038	BP100244	17 July 2002 (30 months)
PCT/FI01/00120	BP100777	11 August 2002 (30 months)
PCT/FI01/00261	BP100682	16 September 2002 (30 months)
PCT/FI01/00508	BP101224	29 November 2002 (30 months)

The change applies to all designated states except the U.S.

Nokia Corporation has authorized Berggren Oy Ab, Jaakonkatu 3A, FIN-00100 Helsinki, Finland, to continue to act as their agents in the above applications.

We enclose a copy of a general power of attorney and a copy of the Extract from the Trade Register in Finnish and its translation into English.

We respectfully request that the change of the applicant is recorded as soon as possible.

BERGGREN OY AB

Encl.

Copy of general power of attorney
Copy of Extract from the Trade Register in Finnish
Copy of Extract from the Trade Register, English translation